REMARKS

In the Office Action the Examiner noted that claims 1-16 were pending in the application. The Examiner objected to the form of claims 11 and 12 and objected to claims 13-15 as being dependent upon a rejected base claim. Claims 1-6, 10 and 16 were rejected. By this Amendment, various claims have been amended. Thus, claims 1-16 are pending in the application. The Examiner's objections and rejections are traversed below.

The Abstract

In accordance with the Examiner's objection on page 2 of the Office Action, an amended Abstract is submitted herewith.

Objection to Claims 11 and 12

On page 2 of the Office Action the Examiner objected to claims 11 and 12 as being in improper form. Claims 11 and 12 have been amended in order to overcome this objection.

Objection to Claim 1

On page 3 of the Office Action the Examiner objected to claim 1. By this Amendment claim 1 has been amended in an effort to clarify the language of the last paragraph of claim 1. It should now be clear from claim 1 that the input light beam is made into an elliptically polarized light or a circularly polarized light after being transmitted through the phase difference variable element. The elliptically polarized light or circularly polarized light is thereafter transmitted through the phase plate to thereby be made into a linearly polarized light, so that the polarization plane of the input light beam is rotated by an angle corresponding to the phase difference applied by the phase difference variable element.

It is submitted that claim 1, as amended, clearly sets forth the subject matter of the invention.

The Prior Art Rejections

On pages 3 and 4 of the Office Action the Examiner rejected claims 1-2, 5-6, 10 and 16 as anticipated by EP 0932068A2. On pages 5 and 6 of the Office Action the Examiner rejected

claims 3 and 4 as obvious over the EP '068 application either taken alone or in view of U.S. Publication US 2001/0055262 A1.

The Present Claimed Invention

The present claimed invention as set forth, for example, in claim 1 is directed to a variable polarization plane rotator for rotating a polarization plane of linearly polarized light. The claimed rotator includes a phase plate, a phase difference variable element and a phase difference adjustment section. As set forth in claim 1, the phase plate has an optical axis in the same direction as (i.e., inclined at a zero degree angle) or at a ninety degree angle relative to a polarization direction of an input light beam. The phase plate applies a ninety degree phase difference to the light beam being transmitted, between a polarization component parallel to said optical axis and a polarization component perpendicular to the optical axis. Elliptically polarized light or circularly polarized light transmitted to the phase plate is thereby made into linearly polarized light. The phase difference variable element has an optical axis at a forty-five degree angle relative to the optical axis of the phase plate. It applies to the light beam being transmitted, a variable phase difference between the polarization component parallel to the optical axis and the polarization component perpendicular to the optical axis. After the light beam is transmitted through the phase difference variable element, the input light beam is made into an elliptically polarized light or a circularly polarized light. The phase difference adjustment section adjusts the variable phase difference of the phase difference variable element.

According to the variable polarization plane rotator of the present claimed invention, rotation of the polarization plane can be controlled by the combination of the phase difference variable element and the phase plate. Therefore, it is possible to achieve miniaturization and low cost compared to a conventional Faraday rotator. At the same time, it becomes possible to control the rotation angle easily since the rotation angle of the polarization plane can be arbitrarily set by adjusting the phase difference applied by the phase difference variable element.

The Prior Art

European Published Patent Application EP 932068 (the '068 reference) is directed to a tunable optical filter having a variable wavelength characteristic of transmittance. The Examiner has specifically referenced Figure 21 of the '068 reference which shows a tunable optical filter

including a variable phase shifter 6 between a first polarizer P1 and a second polarizer P2. Paragraph 74 of the '068 reference states that "the variable phase shifter 6 gives a phase difference (retardation) between a polarization component parallel to the optical axis and a polarization component orthogonal to its optical axis. The phase difference is made variable by a control signal supplied to the variable phase shifter 6."

Paragraph 74 of the '068 reference states that the first polarizer P1, a birefringent plate BP, a variable Faraday rotator FR and a second polarizer P2 are arranged in the same manner illustrated in the embodiment of Figure 7A. The variable phase shifter 6 is positioned between the first polarizer P1 and the birefringent plate BP.

Paragraph 36 of the '068 reference states "a birefringent plate capable of giving a phase difference corresponding to a length 20 to 100 times an operating wavelength is adopted as the birefringent plate BP."

U.S. Patent Publication 2001/0055262 to Kasazumi et al. is cited by the Examiner in the rejection of claim 4 only on the basis that this publication teaches the use of a liquid crystal device as a phase difference variable element as set forth in the last sentence of the Abstract.

The Present Claimed Invention Patentably Distinguishes Over the Prior Art

As indicated above, the Examiner is generally taking the position that the birefringent plate BP of the '068 reference corresponds to the claimed phase plate, and that the variable phase shifter 6 of the '078 reference corresponds to the claimed phase difference variable element of claim 1. On page 4 of the Office Action the Examiner has acknowledged that "the reference does not explicitly teach the use of a phase difference adjustment section that adjust the variable phase difference of the phase difference variable element...." However, the Examiner has taken the position that such a control element is inherent in the variable phase shifter 6 of the '068 reference.

Referring to the birefringent plate BP of the '068 reference, it is disclosed that when an angle between the optical axis (the axis C1- see Figure 8 of the '068 reference) of the birefringent plate and the transmission axis P1A that corresponds to the direction of polarization of the input light beam of the first polarizer P1, and a different angle between the transmission axis P2A of the second polarizer P2 and the optical axis C1 are defined as Φ and θ, respectively, an equation $\Phi = \theta + \delta$ can be established. In this case, δ is an angle between the respective transmission axes P1A and P2A of the first and second polarizers P1 and P2. These features

are described in paragraphs 39 and 40 and Figure 8 of the '068 reference. Further, in paragraph 42 of the '068 reference, it is stated that in order to make the transmitted light intensity of the variable optical filter have wavelength dependence, the condition $\Phi \neq n\pi/2$ or $\theta \neq n\pi/2$ (where n is an integer) must be satisfied. Applicants note that this portion of the'068 reference is clearly different from the claimed feature of claim 1, wherein the phase plate has an optical axis in the same direction as (i.e., $\Phi = 0$) or at a ninety degree angle to (i.e. $\Phi = \pi/2$). This difference in the optical axis of the phase plate between the present claimed invention and the '068 reference produces a clear difference in the polarization condition of the output light beam in each case. In particular, in the '068 reference as described in paragraph 41 and Figure 8, when the rotation angle alpha of the Faraday rotator FR is made 0 (alpha = 0), it is stated that the polarization state at the output of the birefringent plate BP becomes an ellipse including a circle. Thus, if the above-analyzed disclosure of the '068 reference is applied to Figure 21 in which a variable phase shifter 6 is interposed, it is clear that when the phase difference in the variable shifter 6 and the rotation angle of the Faraday rotator FR are both made 0, the output of the birefringent plate PB will be an elliptically polarized light. Therefore, it is submitted that the '068 reference does not teach or suggest a phase plate that has an optical axis in the same direction as, or at a ninety degree angle relative to, a polarization direction of an input light beam.

In addition, it is noted that paragraph 36 of the '068 reference states that to realize wavelength dependence of transmittance, a birefringent plate having a thickness larger than that of a quarter-wave plate or a half-wave plate, and specifically a birefringent plate having a thickness sufficiently larger than an operating wavelength, is required. This suggests a technical content far different from the features of the present claimed invention in which the phase plate applies to the light beam being transmitted, a ninety degree phase difference between a polarization component parallel to the optical axis and a polarization component perpendicular to the optical axis.

In the Office Action the Examiner takes the position that paragraph 23 of the '068 reference suggests use of a doubly refractive ¼ wavelength plate. However, this portion of the disclosure in the '068 reference is related to the construction of the conventional birefringent plate shown in Figure 1 of the'068 reference and does not have any relation to the construction of Figure 21. Thus, applicants submit that the birefringent plate BP employed in the construction and arrangement of Figure 21 of the '068 reference is different from the ¼ wavelength plate from the viewpoint of the plate thickness. Therefore, it is submitted that the prior art does not teach or

suggest the claimed feature in which the phase plate applies to the light beam being transmitted, a ninety degree phase difference between a polarization component parallel to the optical axis and a polarization component perpendicular to the optical axis.

It is further submitted that the prior art does not teach or suggest a phase difference variable element that has an optical axis at a forty-five degree angle relative to the optical axis of the phase plate. In particular, the description in paragraph 76 of the '068 reference states that "it is preferable to set the angle between the optic axis of the variable phase shifter 6 and the optic axis of the birefringent plate BP to n π /2 (n is an integer).

In contrast, the present claimed invention specifies that the angle between the optical axis of the phase variable element and the optical axis of the phase plate is ± 45 degrees (i.e., π /4). Thus, the construction and arrangement of the present invention is different from that of the '068 reference.

In summary, it is submitted that claim 1 patentably distinguishes over the prior art. In addition, claims 2-6, 10 and 16 depend directly or indirectly from claim 1 and include all of the features of that claim plus additional features which distinguish over the prior art. Therefore, it is submitted that these claims also distinguish over the prior art.

Summary

It is submitted that none of the references, either taken alone or in combination teach the present claimed invention. Thus, claims 1-16 are deemed to be in a condition suitable for allowance. Reconsideration of the claims and an early notice of allowance are earnestly solicited.

Respectfully submitted,

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